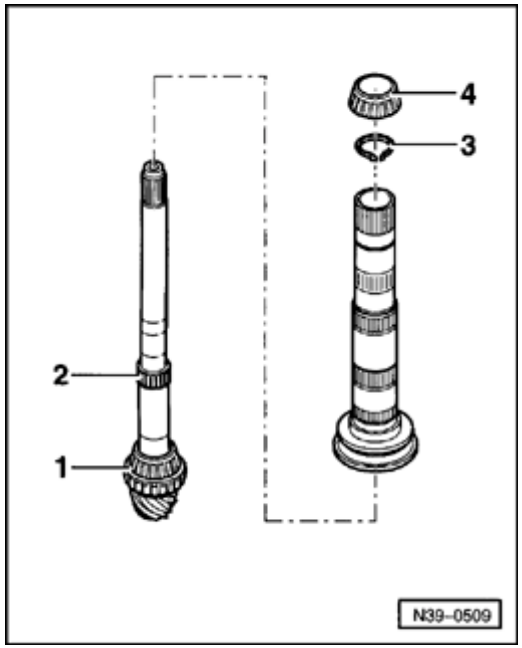
Speedometer Vehicle Speed Sensor (VSS), removing and installing

Total shim thickness Stotal for shim S3 + S4, determining

Adjust preload of tapered roller bearings for pinion shaft with hollow shaft

- Differential removed

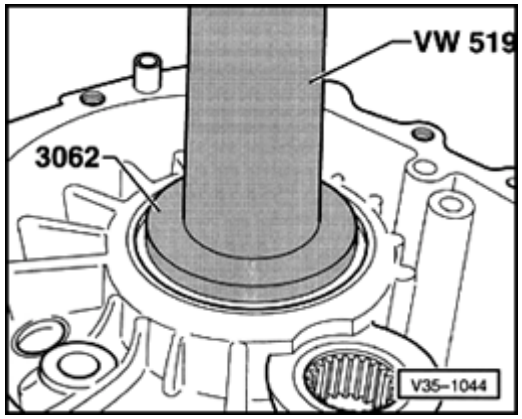


- Press inner race -1- for double tapered roller bearing onto pinion shaft and secure ⇒ Page 35-21 .
- Position needle bearing -2-.
- Install circlip 3 onto hollow shaft and press on inner race for tapered roller bearing -4- ⇒ Page 35-21 .
- Insert pinion shaft in hollow shaft.

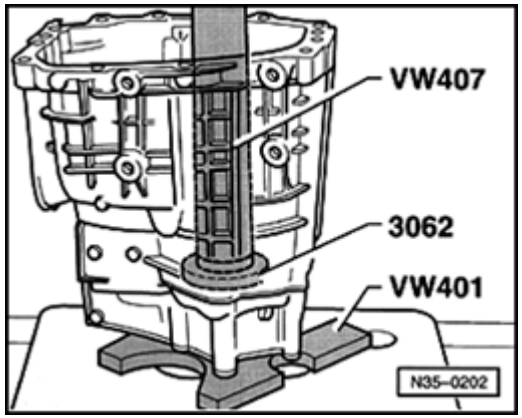
Note:

Illustration shows hollow shaft without gears. The adjustment of the pinion shaft can be done with or without gears.

39-42



- Install double tapered roller bearing outer race for pinion shaft in transmission housing without shims ⇒ Fig. 3, Page 35-31 .



- Install tapered roller bearing outer race for pinion shaft in transmission cover together with shim S4* (1.0 mm thick) ⇒ Fig. 8, Page 35-33 .

Notes:

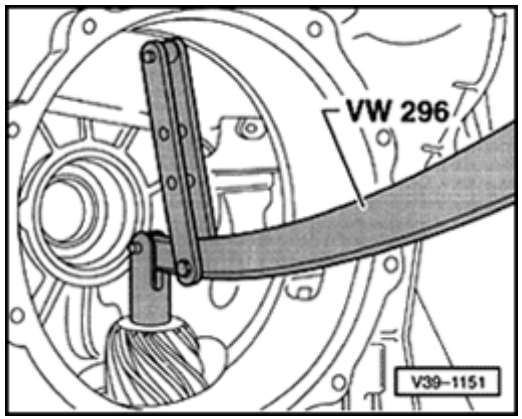
- *A shim S4 with a thickness of 1.0 mm is installed for initial measurement. It is referred in the following text as S4*. After determining measurement "e", S4* is replaced with the appropriate shim S4.*
- *When taking measurements, always install the rubber washer together with the pressure plate for the rubber washer ⇒ Page 35-29 .*

- Install fully assembled pinion shaft with hollow shaft into transmission housing.

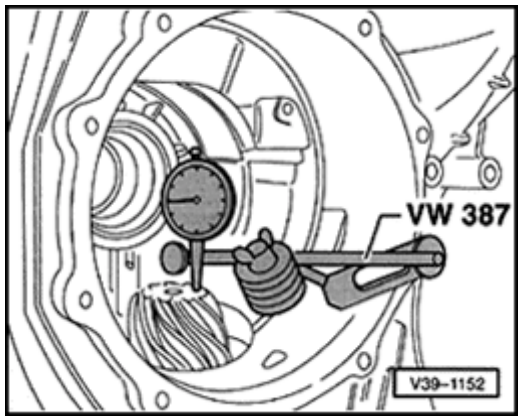
39-43

- Install transmission cover and tighten bolts to 22 Nm (16 ft lb).

- Turn transmission so transmission cover faces downward.



- Press down on face of pinion shaft using VW296 removal tool until tapered roller bearing outer race contacts transmission cover.
- While still maintaining pressure, rotate pinion shaft 5 turns in each direction opposite hollow shaft to settle double tapered roller bearing.
- Rotate pinion shaft together with hollow shaft 5 turns in each direction to settle tapered roller bearing.



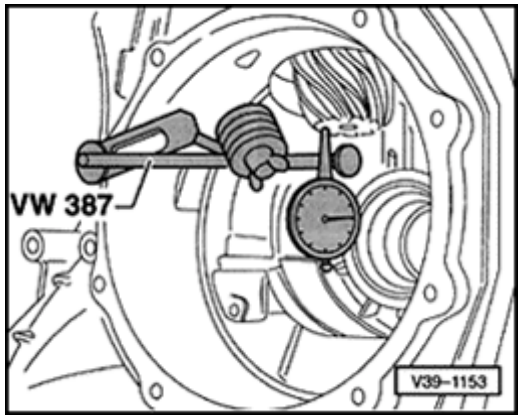
- Assemble measuring equipment, use 30 mm dial indicator extension.
- Set dial indicator (3 mm measuring range) to "0" with 1 mm preload.

Note:

The dial indicator extension must contact the machined surface on the face of the pinion shaft.

- Turn transmission 180° so transmission cover faces upward.

- Rotate pinion shaft together with hollow shaft 5 turns in each direction to settle tapered roller bearing. Otherwise measurement will not be correct.



- Read off and note play indicated on dial indicator.

  Measurement in example: 0.45 mm

Note:

If the measurement has to be repeated, first rotate the pinion shaft with hollow shaft again 5 turns in each direction to settle the tapered roller bearing. Then set the dial indicator to "0" again with 1 mm preload.

Formula:

Stotal = S4* + measurement + bearing preload

Example:

	Inserted shim S4*	1.00 mm
+	Measurement (example)	0.45 mm
+	Bearing preload (constant)	0.15 mm
=	Total shim thickness Stotal for S3 + S4	
		1.60 mm

Determining thickness of shim S3*

Formula:

S3* = Stotal - S4*

Example:

	Total shim thickness Stotal for S3 + S4	1.60 mm
-	Inserted shim S4*	1.00 mm
=	Thickness of shim S3*	0.60 mm

- Remove double tapered roller bearing outer race, install shim S3* in transmission housing and re-install outer race ⇒ Fig. 3, Page 35-31 .

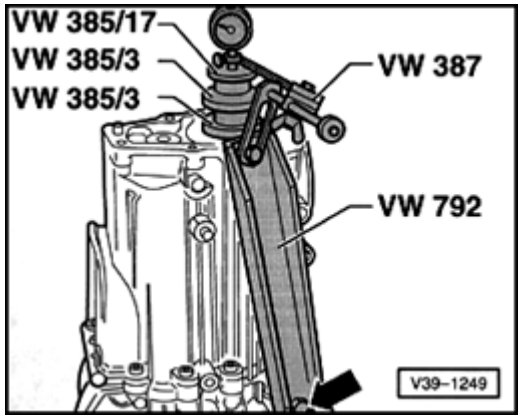
- Insert fully assembled pinion shaft into transmission housing again.

- Install transmission cover and tighten bolts to 22 Nm (16 ft lb).

- Rotate pinion shaft together with hollow shaft 5 turns in each direction, then rotate pinion shaft

separately in relation to hollow shaft 5 turns in each direction, to settle tapered roller bearings.

39-46



- Install measuring tools and secure to transmission housing using bolt (arrow).
- Set dial indicator (3 mm measuring range) to "0" with 2 mm preload.
- Loosen transmission cover bolts and turn pinion shaft several times.
- If correct shims have been selected, dial indicator will now indicate the following value:

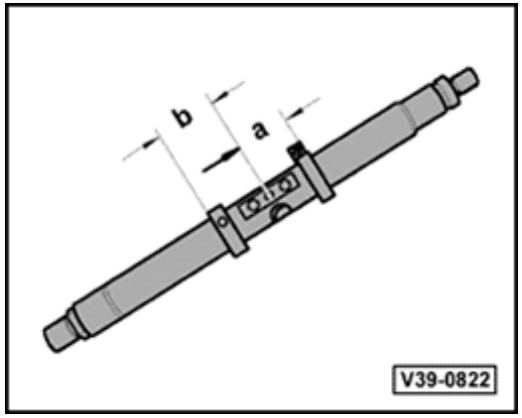
  0.05-0.15 mm
- Tighten transmission cover bolts again to 22 Nm (16 ft lb).
- Remove measuring tools.
- To settle tapered roller bearings, rotate pinion shaft together with hollow shaft 5 turns in each direction, then rotate pinion shaft separately in relation to hollow shaft 5 turns in each direction.

39-47

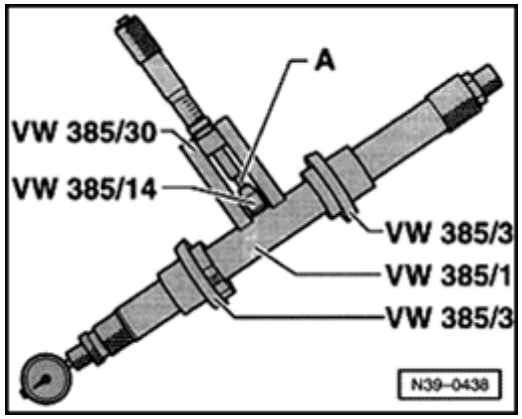
Determining measurement "e"

Note:

Measurement "e" is required to determine the final shim thickness of S3 and S4.

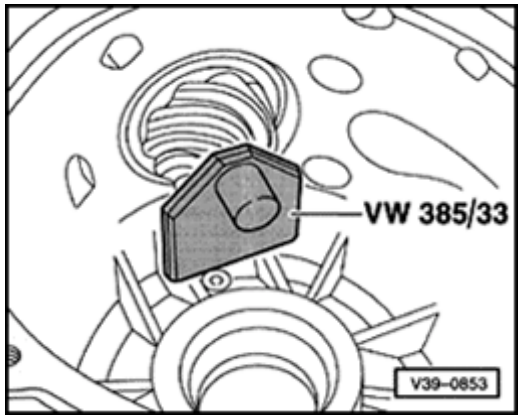


- Set adjustment rings of universal mandrel using VW385/1 measuring bar to the following measurements:
  - Dimension a: 35 mm (1.378 in.)
  - Dimension b: 75 mm (2.953 in.)



- Assemble VW385/1 measuring bar as illustrated:
  - Dial indicator extension -A-, 6.5 mm long
  - VW385/30 master gauge-adjustable
- Set VW385/30 master gauge to Ro = 54.95 mm (2.163 in.)for 170 mm (6.693 in.) diameter ring gear and install on universal mandrel.
- Set dial indicator (3 mm measuring range) to "0" with 2 mm preload.

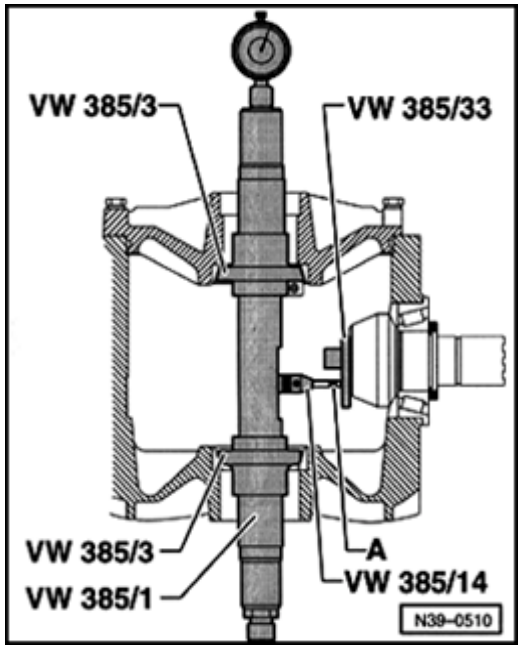
39-48



- Place end gauge on face of pinion shaft.

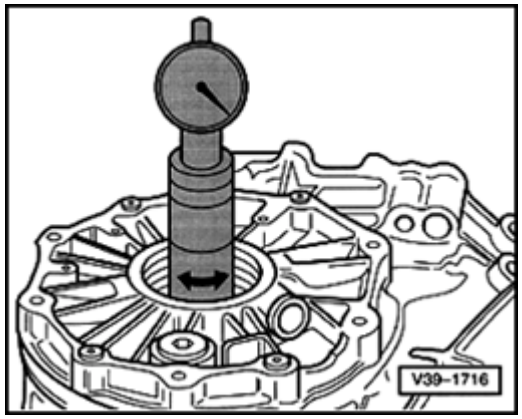
Note:

Make sure gauge contact surface is precisely installed and free of oil.



- Remove master gauge and install measuring mandrel into transmission housing.
  - Dial indicator extension -A- = 6.5 mm long must be installed.
  - The VW385/3 centering disc faces cover for final drive
- Install differential cover and tighten 4 bolts to 22 Nm (16 ft lb).
- Using adjustable ring, pull 2nd VW385/3 centering disc out as far as possible, so mandrel can only just be turned by hand.

39-49



- Turn mandrel until dial indicator plunger tip touches end gauge on pinion shaft head, measure maximum runout (return point).

Measurement in following example "e" = 0.26 mm (red scale)

Note:

After removing universal mandrel, and with VW385/30 master gauge in place, check dial indicator again to see if it indicates "0" with 2 mm preload, otherwise correct adjustments.

Determining thickness of shim "S3"

Formula:

S3 = S3* + r + e

(-e- in black scale)

or

S3 = S3* + r - e

(-e- in red scale)

Notes:

The deviation "r" (tolerance) related to the VW385/30 master gauge "Ro" is measured for the final drive sets supplied as replacement parts and marked on the outer circumference of the ring gear.

- If measurements are based on red scale, subtract value "e."

- If measurements are based on black scale, add value "e."

Example:

	Shim S3* installed	0.60 mm
+	Deviation r	0.38 mm
-	Value measured for "e" (in red scale)	0.26 mm
=	Thickness of shim S3	0.72 mm

- Determine shim(s) according to table. Part numbers ⇒ parts catalog

The following shims are available for "S3"

Shim thickness (mm)1)		
0.40	0.55	0.70
0.45	0.60	0.75

0.50	0.65	

1) Using shim tolerances it is possible to find the exact shim thickness required, insert two shims if necessary.

39-51

Determining thickness of shim "S4"

Formula:

S4 = Stotal - S3

Example:

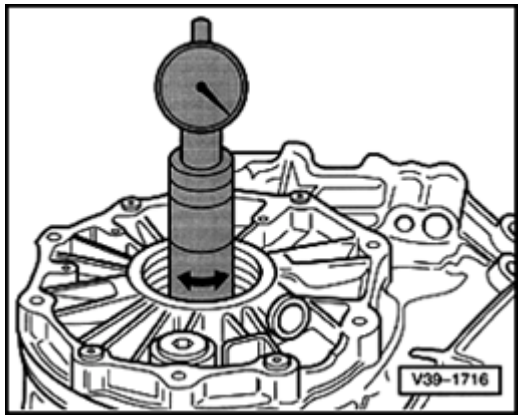
	Total shim thickness Stotal for S3 + S4	1.60 mm
-	Thickness of shim S3	0.72 mm
=	Thickness of shim S4	0.88 mm

- Determine shim(s) according to table. Part numbers ⇒ parts catalog

Available shims for "S4"

Shim thickness (mm)1)		
0.45	0.65	0.85
0.50	0.70	0.90
0.55	0.75	
0.60	0.80	

1) Using shim tolerances it is possible to find the exact shim thickness required, insert two shims if necessary.



Checking measurement

Checking dimension "r"

- Install pinion shaft/hollow shaft with measured shims S3 and S4.

- Turn hollow shaft against pinion shaft 5 turns in both directions, so tapered roller bearing can settle.

- Insert universal mandrel ⇒ determining measurement "e", ⇒ Page 39-47 and perform check measurement.
- Read off dial indicator counterclockwise (red scale).

  If the shims have been correctly selected, deviation "r" (marked on outer circumference of ring gear) must be displayed - within a tolerance of ± 0.04 mm

Note:

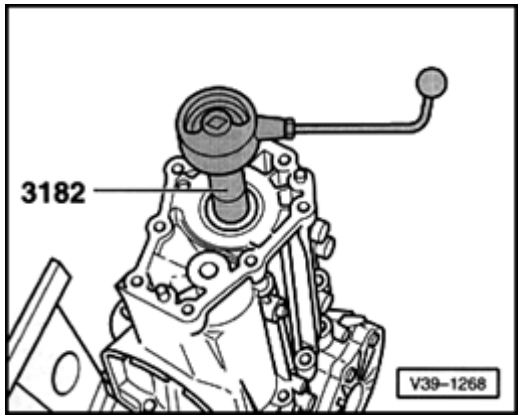
After removing universal mandrel, and with VW385/30 master gauge in place, check dial indicator again to see if it indicates "0" with 2 mm preload, otherwise correct adjustments.

Measuring friction torque

Notes:

- *Pinion shaft/hollow shaft tapered roller bearings are low friction bearings. Therefore the friction torque has only a limited use as a check. Correct adjustment is only possible by determining the total shim thickness Stotal.*

- *Do not additionally oil new tapered roller bearings to perform the friction torque measurement. These bearings have already been treated with a special oil by the manufacturer.*



- Install torque gauge, 0-600 Ncm (53 in. lb) on pinion shaft.
- Read off friction torque.

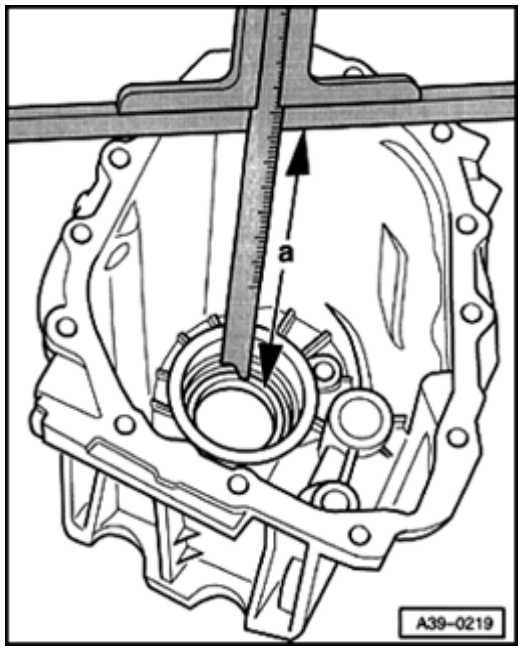
Friction torque specification:

New bearings	Used bearings
150-250 Ncm (13-22 in. lb)	30-60 Ncm (3-5 in. lb)

Transmission cover, replacing (re-calculating shim S4

Special tools and equipment

- VW385/3 centering disc (2x)
- VW385/17 magnetic plate
- VW387 dial indicator holder
- VW792 installation arbor
- Dial indicator
- Dial indicator extension
- Depth gauge with minimum 5/100 mm precision



- Clean housing mating surfaces.

- Measure difference in depth -a- on old and new transmission covers.

Example:

	Depth "a" (old transmission cover)	257.40 mm
	Depth "a" (new transmission cover)	257.55 mm
=	Difference	0.15 mm

- Install thicker shim S4 if new transmission cover is deeper.
- Install thinner shim S4 if old transmission cover is deeper.

Example:

	Previous shim S4	0.95 mm
+	Difference	0.15 mm
=	New shim S4	1.10 mm

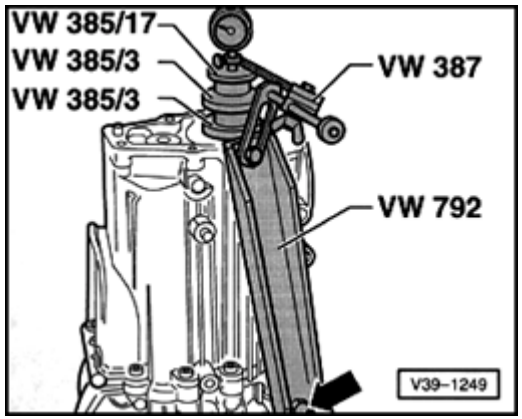
Available shims ⇒ table, ⇒ Page 39-51 .

- Press tapered roller bearing outer race with shim S4 into transmission cover ⇒ Fig. 8, Page 35-33 .

- Reinsert assembled pinion shaft into transmission housing fully.

- Install transmission cover and tighten bolts to 22 Nm (16 ft lb).

- To settle tapered roller bearings, rotate pinion shaft together with hollow shaft 5 turns in each direction, then rotate pinion shaft separately in relation to hollow shaft 5 turns in each direction.



- Install measuring tools and secure with bolt (arrow) to transmission housing.
- Set dial indicator (3 mm measuring range) to "0" with 2 mm preload.
- Loosen transmission cover bolts and turn pinion shaft several times.

If correct shims have been selected, dial indicator will now indicate following value:

0.05-0.15 mm

If this reading is not obtained the adjustment must be corrected.

Ring gear, adjusting

Adjusting differential

For a list of the repairs which will require the ring gear to be adjusted ⇒ table, ⇒ Page 39-37 .

Special tools and equipment

- VW382/10 extension pin
- VW385/17 magnetic plate
- VW386A clamping piece
- VW387 dial indicator holder
- VW388 measuring lever
- VW402 thrust plate
- VW408A punch
- VW472/1 pressure piece
- VW521 adjustment tool

- Torque gauge 0-600 Ncm (53 in. lb)
- Dial indicator
- Dial indicator extension

39-58

Determining total shim thickness "Stotal" (S1 + S2)

Adjusting preload of tapered roller bearings for differential

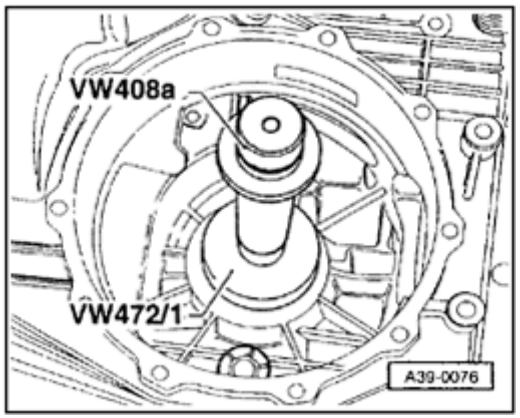
- Pinion shaft removed

Note:

If only the tapered roller bearings for the differential are being replaced, the ring gear can be removed from the differential housing. The pinion shaft does not have to be removed.

- Remove seals and outer races of both tapered roller bearings for differential.

- Remove shims ⇒ Page 39-21 .

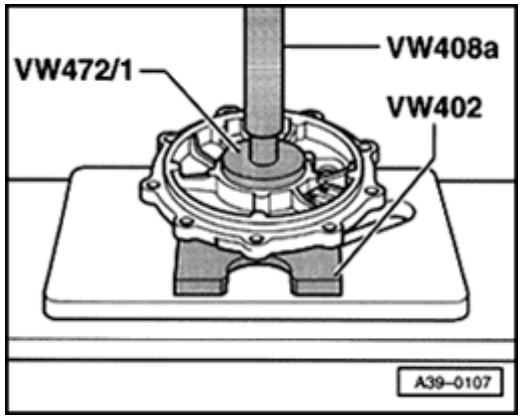


- Press right tapered roller bearing outer race with shim S2 into transmission housing ⇒ Fig. 2, Page 39-27 . Shim S2* with thickness of 1.20 mm (two 0.60 mm shims) is used for initial measurement.

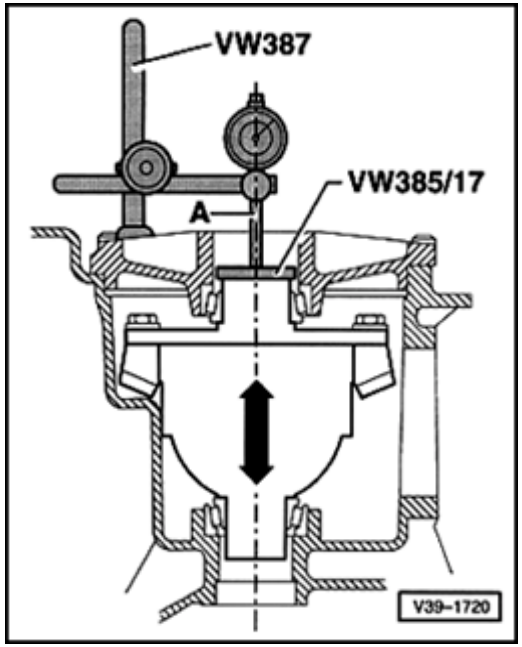
Note:

For measurement purposes, a shim S2 of 1.20 mm is initially inserted and referred to as S2 in the following text. After determining backlash, S2* will be replaced by the correct shim S2.*

39-59



- Press tapered roller bearing outer race into differential cover without shim S1 ⇒ Fig. 8, Page 39-31 .
- Insert differential without speedometer gear drive into transmission housing. Ring gear is positioned on left-hand side infront of final drive cover.
- Install differential cover with 4 bolts and tighten to 25 Nm (18 ft lb).
- Position transmission so differential cover faces upward.
- Turn differential 5 turns in both directions so tapered roller bearings settle.



- Assemble measuring equipment, using 30 mm dial indicator extension.
- Set dial indicator (3 mm measuring range) -A- to "0" with 2 mm preload.

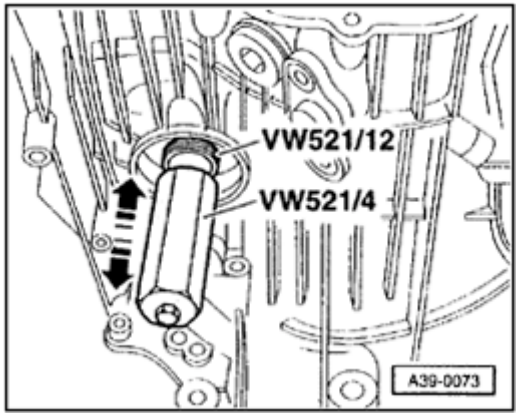
Note:

The tip of the dial indicator must be positioned on the center of the differential.

- Lift differential without turning, and read off play on dial indicator.

- Measurement in following example: 0.62 mm

Notes:



- *To lift the differential, attach VW521/4 locking sleeve and VW521/12 on the right of the differential (housing side).*
- *If the measurement has to be repeated, the pinion shaft with hollow shaft must be turned 5 turns in each direction first to settle the tapered roller bearing.*

Formula:

Stotal = S2*- + measurement + bearing preload

Example

	Inserted shim(s) S2*	1.20 mm
+	Measured value	0.62 mm
+	Bearing preload (constant value)	0.30 mm
=	Total thickness Stotal for S1 + S2	2.12 mm

Determining thickness of shim "S1*"

Notes:

- *The preliminary adjustment shim S1* will be replaced with the final shim S1 after determining the backlash.*
- *The total shim thickness Stotal remains unchanged.*

Formula:

S1* = Stotal - S2*

Example:

	Total thickness Stotal for S1 + S2	2.12 mm
-	Inserted shim(s) S2*	1.20 mm
=	Thickness of shim S1*	0.92 mm

39-62

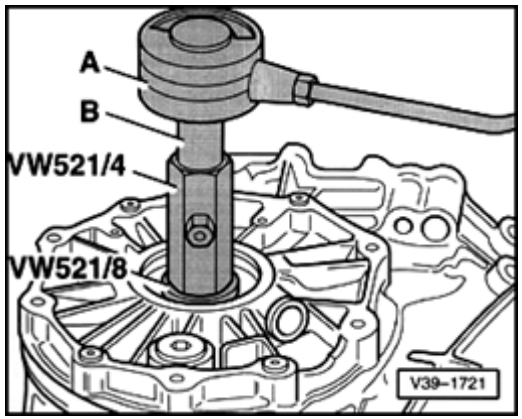
Measuring friction torque

Notes:

- *Differential tapered roller bearings are low friction bearings. Therefore the friction torque only has a limited use as a check. Correct adjustment is only possible by determining the total shim thickness Stotal.*

- *Do not additionally oil new tapered roller bearings for friction torque measurement. The bearings have already been treated with a special oil by the manufacturer.*

- Pinion shaft removed



- Install torque gauge 0-600 Ncm (53 in. lb) -A- onto differential.

B - Socket

- Read friction torque.

Friction torque specifications:

New bearings	Used bearings
150-350 Ncm (13-31 in. lb)	30-60 Ncm (3-5 in. lb)

Note:

For a readjustment of the final drive gear set (pinion shaft and ring gear), the pinion shaft adjustment should now be checked ⇒ Page 39-39 .

39-63

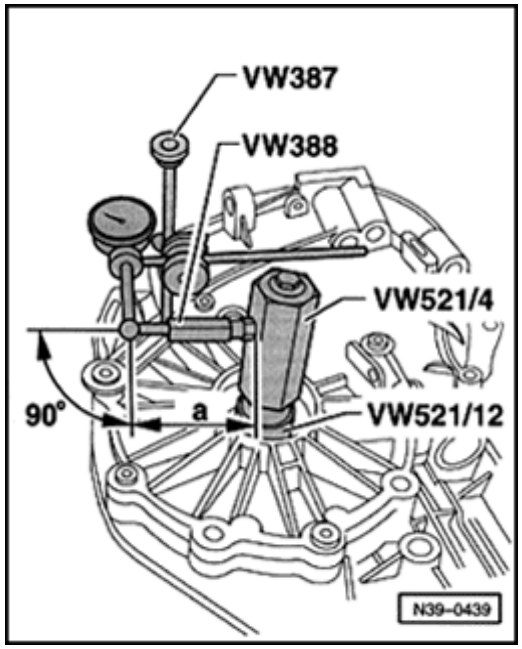
Measuring backlash

Position of ring gear in transmission housing

- Pinion shaft with shims S3* and S4* installed

- Install differential.

- Turn differential 5 turns in each direction to settle tapered roller bearings.



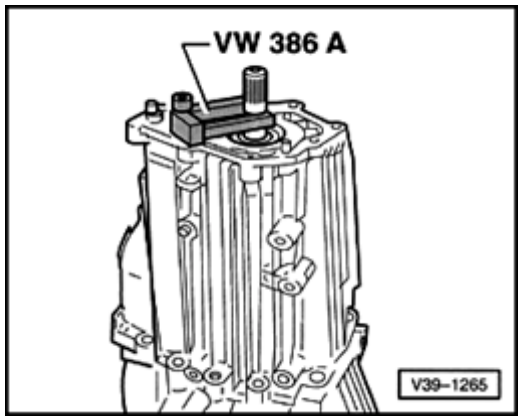
- Secure VW387 dial indicator holder onto housing.
- Attach VW521/4 locking sleeve and VW521/12.
- Install dial indicator and VW382/10 extension pin (6 mm flat).
- Adjust VW388 measuring lever to dimension -a-:

  Distance -a-: 67 mm (2.637 in.) for 170 mm (6.693 in.) diameter ring gear.
- Determine play between teeth flanks as follows:
  - Turn ring gear until it makes contact with tooth flank (end of backlash travel).
  - Set dial indicator to "0" with 2 mm preload.
  - Turn ring gear back against opposite tooth flank (backlash).

- Recording (backlash) indicated on gauge.

- Turn ring gear 90° further each time and repeat measurement 3 times.

Notes:



- *Install VW386A clamping piece if the pinion shaft rotates when the differential is turned. This way the exact backlash can be measured.*
- *Loosen clamping piece in order to turn the ring gear further.*

Determining average backlash

- Add four measured values together and divide by four.

Example:

	1st measurement	0.28 mm
+	2nd measurement	0.30 mm
+	3rd measurement	0.30 mm
+	4th measurement	0.28 mm
=	Sum of measured values	1.16 mm

- Result: the average backlash is 1.16 mm ÷ 4 = 0.29 mm

CAUTION!

If the individual measurements differ by more than 0.06 mm from each other, the installation of the ring gear or the final drive gear set

itself is not correct. Check installation, replace final drive gear set if necessary.

Determining thickness of shim S2

Formula:

S2 = S2* - backlash + lift

Example:

	Inserted shim S2*	1.20 mm
-	Average backlash	0.29 mm
+	Lift (constant value)	0.15 mm
=	Thickness of shim S2	1.06 mm

- Determine shim(s) according to table. Part numbers ⇒ parts catalog

The following shims are available for S2

Shim thickness (mm)1)		
0.45	0.65	0.85
0.50	0.70	0.90
0.55	0.75	
0.60	0.80	

1) By using shim tolerances it is possible to find exact shim thickness required, insert two shims if necessary.

Determining thickness of shim "S1"

Formula:

S1 = Stotal - S2

Example:

	Total shim thickness Stotal for S1 + S2	2.12 mm
-	Thickness of shim S2	1.06 mm
=	Thickness of shim S1	1.06 mm

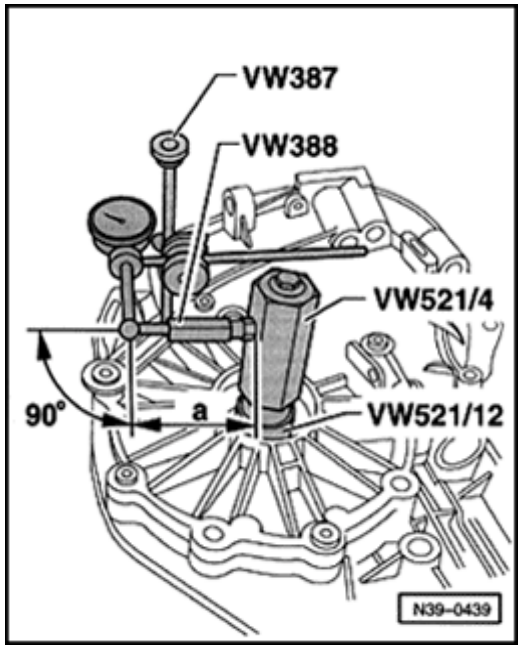
- Determine shim(s) according to table. Part numbers ⇒ parts catalog

The following shims are available for S1

Shim thickness (mm)1)		
0.45	0.65	0.85
0.50	0.70	0.90
0.55	0.75	
0.60	0.80	

1) By using shim tolerances it is possible to find the exact shim thickness required, insert two

shims if necessary.



Checking measurement

- After installing shims S1 and S2, turn differential 5 turns in both directions so that tapered roller bearings settle.
- Measure backlash four times on circumference.

  Specifications: 0.12-0.22 mm

Notes:

- *If the backlash lies outside the tolerances, the adjustments must be repeated. The total shim thickness Stotal must remain the same.*
- *The individual measurements must not differ by more than 0.06 mm from each other.*